IMPACT OF COMMUNICATIONS DEVELOPMENTS
ON INFORMATION SERVICES VENDORS

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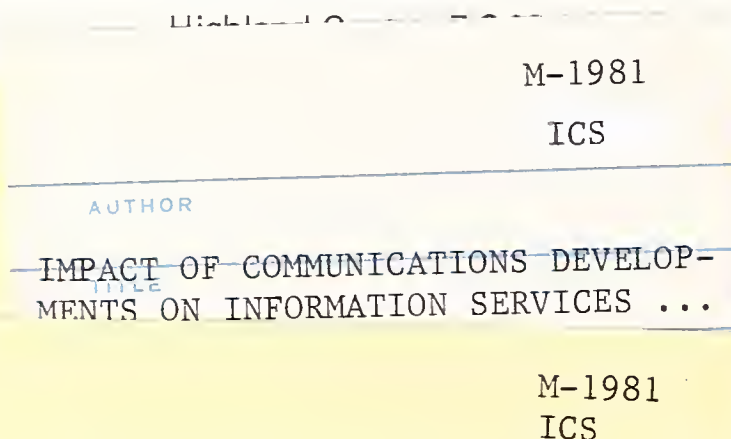
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EXHIBITS

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I INTRODUCTION

I INTRODUCTION

A. PURPOSE AND SCOPE

- This report, produced by INPUT as part of the 1981 Management Planning Program for the Information Services Industry (ISIP), analyzes changing communications technology and services and the opportunities that result for information services companies.

- This topic was selected by a majority of ISIP clients as being of high interest.

- The objectives of the study are to:

    - Identify the current status of communications services.

    - Identify key communications services changes expected over the coming years.

    - Show the impact of these changes on current information services business.

    - Identify new opportunities for information services industry vendors.

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B. RESEARCH AND METHODOLOGY

- Research for this study was obtained both from previous and ongoing INPUT research efforts.

- Research findings and data from previous INPUT studies were incorporated in this study to quantify emerging trends and to integrate relevant information. INPUT studies utilized included:

  - Annual Report, Computer Services Industry - 1980-1985, December 1980.

  - Annual Report, 1980 User Planning Service, November 1980.

  - Personal Computers In Large Corporations, September 1980.

  - Data Communications Considerations For New On-Line Systems, June 1980.

  - User Communications Networks And Needs, November 1980.

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II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

A. MAJOR CONCLUSIONS

- One of the major issues facing information services vendors today is the planning and utilization of communications networks needed to distribute their products.

- Changes in systems economics, user economics, technology, available products and services, competition, and user applications have an effect on this issue.

- As computer and communications technologies have merged, communications services and equipment vendors have actively pursued strategies designed to enlarge their share of what is potentially the world's largest information systems market.

  - Computer and office equipment manufacturers want to provide communications services (either directly or indirectly).

  - Communications carriers want to define new services which are as close to data processing as regulation permits.

  - Computer services companies want to supply communications services (either overtly or covertly).

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- Major corporations are becoming increasingly interested in the computer/communications industry.

- By 1985, the Fortune 500/50 group will spend $13 billion for communications services. Exhibit II-1 diagrams this market. Although the average annual growth rate (AAGR) for the total market is only 10% per year, the portion not held captive by AT&T and other major telephone companies and IBM will grow at a 23% AAGR.

- The network services market not dedicated to voice communications, as illustrated in Exhibit II-2, is also increasing at a 23% AAGR through 1985. Voice communications will increase by 7% compounded annually during the same period.

- It can be assessed, therefore, that 73% of the $4.8 billion market in 1985 for data, message, facsimile, and other network services will be available to independent information services vendors.

- Technologies such as very large scale integration (VLSI), fiber optics, impact and laser printing, video disk storage, etc. are impacting the computer, office automation, and telecommunications industries in a number of different ways:

  - The most obvious is the reduction in the cost of transporting and storing data.

  - The cost of electronic and magnetic storage will soon decrease to the point where these media are cheaper than paper for many applications.

- The driving force behind most network changes is the desire for control. Control includes network management, cost stability, maintenance control, user access control, etc.

  - A significant result is that the fastest selling products in the communications market incorporate network control capabilities. These include

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EXHIBIT II-1

MARKET SIZE ESTIMATE – FORTUNE 500/50
TOTAL COMMUNICATIONS NETWORK MARKET,
BY MARKET SHARE

TOTAL USER EXPENDITURES ($ millions)

$10,000

$5,000

0

1980

1985

YEAR

$8,116

$1,337

$329

$6,450

AT&T and Other
Telephone Companies

$13,110   TOTAL MARKET

$3,510   Market Available to Independent Vendors

$ 770

IBM

$8,830   Captive Market

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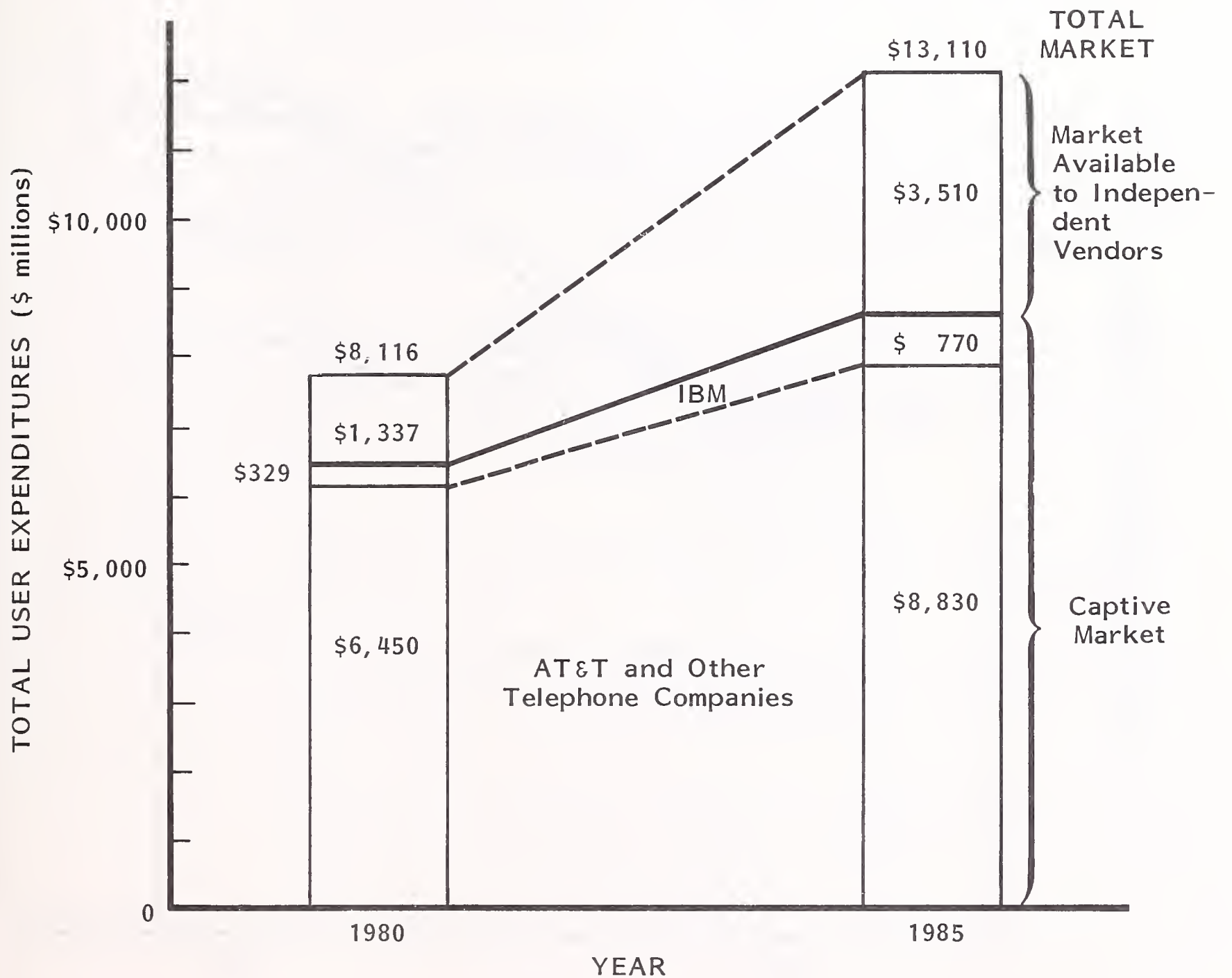
EXHIBIT II-2

MARKET SIZE ESTIMATE - FORTUNE 500/50
TOTAL COMMUNICATIONS NETWORK MARKET,
BY TYPE OF SERVICE
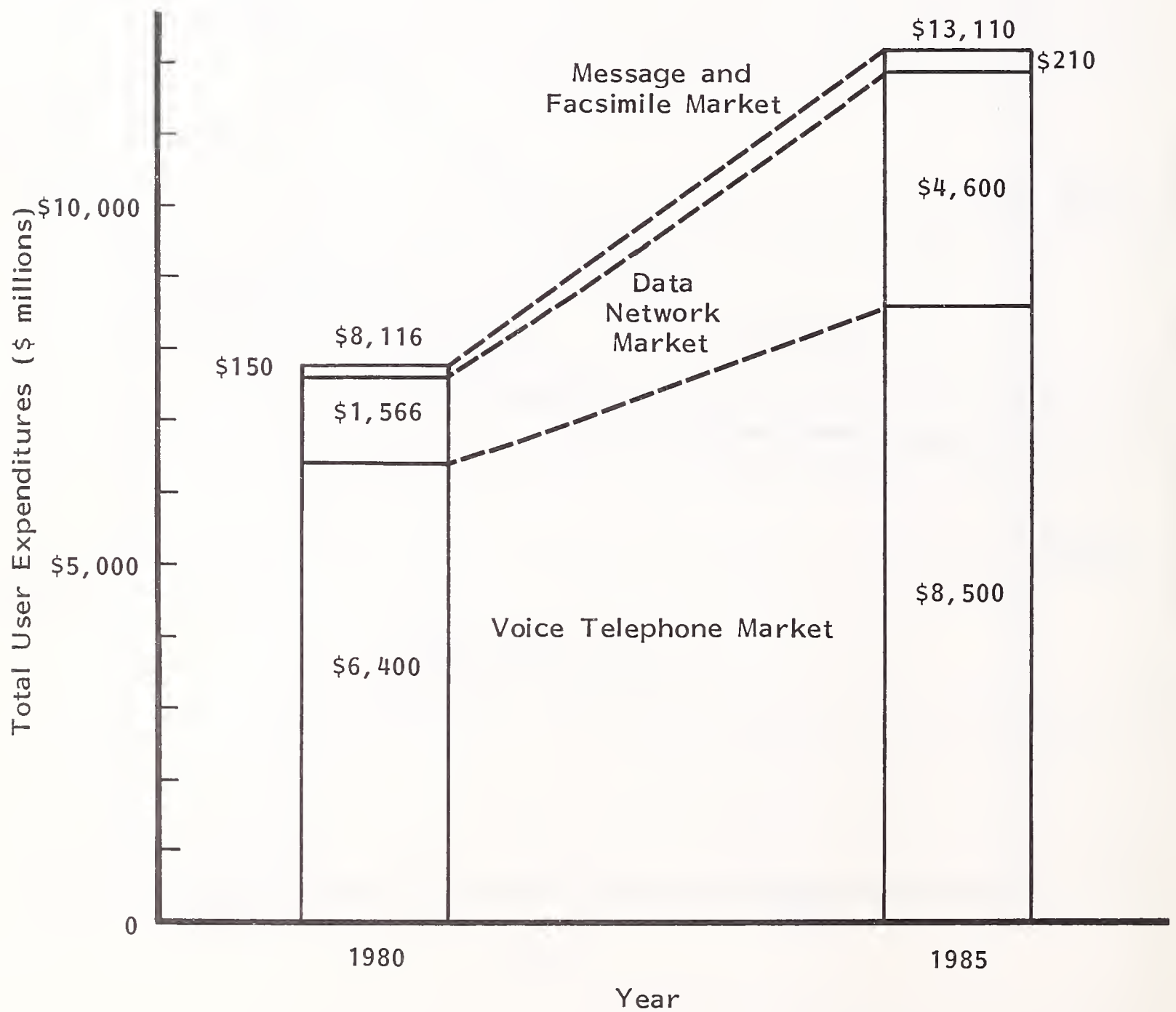
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call detail recording systems in voice networks and centralized network control systems in data networks.

- One of the forces leading users of data communications networks to consider new kinds of solutions and methods of approaching their communications requirements is technology.

    - Much of the technology applicable to data communications networks is derived from developments originated for the much larger voice communications marketplace.

- The AT&T bulk service, TELPAK, was declared illegal and formally withdrawn in 1981. It is, however, unlikely that Bell will be without a bulk tariff for long. As soon as Bell has sufficient excess long distance capacity, either through satellites or fiber optics, some form of bulk tariff is probable.

- Dataphone Digital Service (DDS), first announced by AT&T in 1974, is the first major attempt since the Datran Microwave Network to establish a cross-country "all digital" communications network service. DDS currently services 61 major city calling areas in the United States.

    - AT&T has announced plans to expand the service to a total of 96 cities by the end of 1981.

    - In addition, AT&T is evaluating at least 12 other city calling areas for possible inclusion, and expects FCC approval.

    - In each city calling area, hub access is restricted to within a 50-mile radius. AT&T has stated that current technology is in place to extend this radius up to a minimum of 75 miles.

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- Satellite communications are (by nature and by design) insensitive to distance for long-haul voice, data, and video traffic. It is generally considered economic for these applications (by medium and heavy users) at distances exceeding 500 miles.

    - When coupled with high-speed, short-haul, private microwave ground-based systems, there is practically no area in the 48 contiguous United States that cannot be accessed.

- By far, the greatest obstacle to the efficient implementation of networks is the very limited availability of local loops, particularly high-speed local loops.

- A longer-term development is the use of home computers for interfacing with companies' data systems.

    - One early example of this is an experiment announced by the United American Bank in Knoxville, TN, called "Express Information," which allows home computers to interface with the bank to pay bills, receive account information, and apply for loans.

    - However, the introduction of information/automation into the home and into small enterprises will demonstrate that it will be far easier to produce and deliver information processing equipment than to utilize it.

- The circuit-switched public telephone network, along with private line services from AT&T, will continue to play a major role in data communications for quite some time. Nevertheless, there are situations where alternative offerings may be more cost effective.

- Large users and large market areas will have relatively low-priced transmission capabilities available to them, whereas the smaller and more remote users will have to pay a higher price for transmission.

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- The telephone instrument is likely to become the most powerful human interface, providing additional functions over and above the basic voice communications to the individual at a telephone equipped workstation.

- In a recent INPUT survey, the cost of data communications for remote computing services (RCS) firms averaged 9.1% of total revenues.

- In another survey, AT&T charges ranged from 3% to 50% of the total network cost for larger RCS vendors.

- As a result of (recent) AT&T tariff changes:

    - Private wire costs are increasing substantially.

    - Heavy use WATS lines cost is increasing substantially.

    - Low use WATS cost will be level.

    - Local business line access is growing substantially.

- While the FCC order (Second Computer Inquiry) has already been appealed and will probably spend years in the courts, it should have immediate benefits as all vendors attempt to provide more comprehensive services. The increased competition will result in lower and more competitive computer and communications services prices.

    - The current mood at the FCC is towards deregulation, and the current administration will not reverse this trend.

    - Tymshare, which formed TYMNET as a value added network, is very interested in providing data base services using three data base systems: EXPRESS, FOCUS, and MAGNUM. With the FCC ruling, direct marketing of combined computer/communications services may begin.

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- Computer services companies that have not spun off separate organizations for communications services will now feel free to provide network services without fear of regulation.

● Many companies may decide to utilize data communications capabilities of RCS vendors such as Boeing Computer Services, General Electric Information Services Co., or Tymshare, or use carriers or value added services, such as Telenet, Graphic Scanning, EMCA, etc., rather than expose themselves to the risks of changing technology.

B. RECOMMENDATIONS

● Expand telecommunications capacity as a services offering.

- Propose regional shared-transaction networks to associations, business groups, and corporations.

- Develop and operate information switching systems to interface and integrate local/regional networks into national networks.

- Utilize SBS and other wideband telecommunications networks to balance computer center workloads for processing and for offering disaster recovery system services.

- Understand interactive cable technology evolving in consumer and business information marketplaces.

● Plan to use evolving video disk image storage and processing systems for use in consumer and business applications.

● Develop and maintain mainline applications as national products to include:

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-   On-line, interactive, transaction capability.

-   Central information file data base.

- Incorporate security systems combining software and microprocessor control into network services offerings.

- Provide data communications and processing capabilities at customer sites involved with hardware services and use networks to collect and disperse data. Data are consolidated on the RCS host or forwarded to customer centers.

- Services offered to other information services firms should include the use of value added networks and licenses to use computers and software.

    -   These services are being sold to RCS firms today, because the complexity of network services has increased sufficiently to make it too costly for smaller firms to develop this capability.

- RCS networks will, at a minimum, have to provide interfaces to packet networks, SDLC (Synchronous Data Link Control), and 3270 and other IBM terminals in order to obtain business. In some cases interfaces to a satellite ground station, Telex, TWX, ECOM, Mailgram, or cable TV might be required.

    -   RCS firms should be prepared to offer flexibility in handling carriers, protocols, speeds, codes, terminals, and other equipment.

    -   RCS firms must develop these capabilities for themselves or have arrangements with vendors who do (e.g., Tymnet, Telenet, etc.).

- Networks will be a more valuable component of service since it will be harder to sell processing without value added services.

    -   RCS vendors will have to spend more to develop network capabilities and upgrade them on a regular basis.

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- The demand for data communications is increasing in both domestic and international markets. RCS firms that supply network services will gain processing and other services as well as network business.

- There is an opportunity to provide a "middle man" service that can interface to many or all carriers (over 25); i.e., protocols, speeds, modems, different terminals and computers including word processing systems, than presently exist. This service would aid private networks and other users to address the present unorganized and fragmented situation.

- Bypass AT&T costs and use satellites and cable TV or satellite reception tied into local PBX systems.

- Integrate various services in a network offering.

  - The integration of services for an industrial client could include a data base of parts from many vendors that would be provided to selected industries. Means of ordering and paying for the parts would be included.

  - Shopping at home on cable TV or phone and TV could be combined with payment services and entertainment.

- Requirements for new data communication services for network use will include:

  - Interfaces to satellite ground stations.

  - Interfaces to cable TV.

  - Use of SDLC and other new protocols including Ethernet.

  - Hardware interfaces to PBX systems.

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- Interface to ECOM and the ability to package traffic in their requirements.

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- Interfaces to fiber optics systems which could have new protocols and equipment.

● Two concurrent industry trends, distributed processing and office automation, are making communications requirements a paramount issue in all long-range planning involving data and/or word processing systems. Communications compatibility will become the crucial selection criterion as integration of systems occurs. Service offerings which provide a total system, combining hardware, software, and communications, will become increasingly attractive.

● Vendors must protect their reputation carefully. The communications industry, particularly that segment made up of the major users and their suppliers, is a relatively small community in which a reputation, particularly for bad performance, can be established very quickly and disseminated even more quickly. Such was the case for specialized carriers' performance in remote areas. The reputation lost, probably attributable to overextension of resources, will be difficult to regain and appears to have been avoidable.

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III CURRENT COMMUNICATIONS ISSUES
AND CONSIDERATIONS

III   CURRENT COMMUNICATIONS ISSUES AND CONSIDERATIONS

A.   OVERVIEW

- One of the major issues facing not only remote computing firms but also other types of information services vendors, is the planning and utilization of the communications networks needed to distribute their products.

- Affecting this issue are:

  - Systems economics.

  - User economics.

  - Technology advances.

  - Available products and services.

  - Competition.

  - User applications.

- Many of the information services industry's "buzz" words are directly related to computer/communications networks. Consider:

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- Distributed data processing.

- Data base management systems.

- Distributed data base.

- Packet switching.

- Office automation.

- Multifunction equipment.

- Electronic mail (or message) service.

- Electronic fund transfer systems.

- Any one of these areas is sufficiently complex to warrant intense and specialized analysis.

    - The terms themselves, which frequently lack generally accepted definitions, represent issues of concern to various planning and user groups.

    - The result has been to make computer/communications network planning extremely difficult.

- As computer and communications technologies have merged, communications services and equipment vendors have actively pursued strategies designed to enlarge their share of what is potentially the world's largest information systems market.

    - Computer and office equipment manufacturers want to provide communications services (either directly or indirectly).

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- Communications carriers want to define new services which are as close to data processing as regulation permits.

- Computer services companies want to supply communications services (either overtly and covertly).

- Major corporations are becoming increasingly interested in the computer/communications industry.

- A listing of the major communications services vendors is shown in Exhibit III-I.

- Two concurrent trends - distributed processing and office automation - are making communications requirements a paramount issue in all long-range planning. Communications compatibility will become the crucial selection criterion as integration of systems occurs, and service offerings which provide a total system combining hardware, software, and communications will become increasingly attractive.

- According to government statistics, fewer people will be entering the labor force during the balance of this century.

    - The labor pool annual growth rate will decline each year until approximately 1995.

    - Fewer people will be available for office staffing.

    - Labor will become more expensive because of its scarcity.

- The ratio of electronics technology costs to physical labor costs is becoming more favorable to electronics every year. The cost of technology (all inclusive) is falling 22% to 30% annually while labor rates are climbing 8% to 10% annually.

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EXHIBIT III-1

MAJOR SUPPLIERS OF COMMUNICATIONS SERVICES

- Traditional Leading Common Carriers:

  - AT&T and Bell Subsidiaries
  - GTE
  - United Telecommunications, Inc.
  - Continental Telephone Corp.
  - Central Telephone and Utilities
  - Western Union

- Specialized Common Carriers

  - SPCC (Southern Pacific Communications Co.)
  - MCI Communications Corp.
  - United States Transmission Systems (USTS)
    (Subsidiary of ITT)

- Satellite Communications:

  - AT&T COMSTAR
  - RCA SATCOM
  - Western Union WESTAR
  - American Satellite Corp. (ASC)
  - Satellite Business Systems (SBS)
  - Xerox/Western Union International
  - SPCC
  - Hughes

- Value Added and Packet Switched Public Data Networks

  - TYMNET
  - TELENET
  - GRAPHNET
  - UNINET

- International Record Carriers

  - RCA Global Communications
  - ITT World Communications
  - Western Union International
  - TRT Telecommunications
  - FTC Communications

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- The volume of paperwork is increasing 12% annually. An annual increase of only 8% in labor costs brings the total annual increase of handling paper to 20%.

  - Eighty percent of business correspondence could be handled by electronic mail services.

  - The savings in paper and labor costs alone will soon justify the cost of source document and computer output microfilming without considering the additional savings from reduced storage space requirements.

  - The cost of electronic and magnetic storage will soon decrease to the point where these media are cheaper than paper for many applications. This cross over is likely to take place as early as 1984.

- Telecommunications facilities are expected to have an average annual growth rate of 12% through 1990, while the cost per message continues to decline.

- Technologies such as very large scale integration (VLSI), impact and laser printing, video disk storage, fiber optics, etc. are impacting the computer, office automation, and telecommunications industries in a number of different ways:

  - The most obvious is the reduction in the cost of transporting and storing data.

  - The least obvious impact is the related requirement for supporting capabilities such as programming, training, and selling these devices.

  - Reduced cost rarely implies increased availability in the short term, especially in an industry as massive as the computer communications industry.

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- The increasing availability of low-cost digital communications systems will benefit all information vendors in the long run.

    - The telephone network is becoming digital, particularly in metropolitan areas and in its switching components.

- Satellite-based systems will be utilized primarily for broadcast applications, of which entertainment TV is only a part. Education, specialized business information, vehicle reporting and dispatching, and other mobile communications will all contend for the increasingly valuable radio spectrum.

- Very high bandwidth fiber optic cables will dominate the point-to-point communications market.

B. LOCAL LOOPS

- By far, the greatest obstacle to the efficient implementation of networks is the very limited availability of local loops, particularly high-speed local loops. (The term "local loops" here is employed in the communication context, not in the information system context as popularized in text processing applications.)

    - In the case of local loops, the only practical alternative available today is the telephone company.

    - All of the other elements of a network (long-distance transmission switching equipment, terminal equipment, and inside wiring) are reasonably available. In addition, practical alternatives are becoming more available.

- This obstacle is a particular problem for companies with multiple large operations in the same city. Within the Fortune 500/50 market, there are estimated to be almost 1,000 such operations with more than 2,000 employees each.

- There is a growing realization, fueled by the increasing availability of alternatives, that the vast majority of corporate communications stays within one site. Studies have shown that at least 60% (and in some industries, such as banking, perhaps up to 90%) of the communications traffic remains within a single building.

- It is important to distinguish between the two classes of local networks:

  - Intrabuilding (or intracampus) networks.

  - Intracity networks.

- These two classes of networks are very different types of communications networks, primarily because the constraints that exist in intracity networks do not exist in intrabuilding networks.

- Intracity networks require communication facilities that cross property that is either public or owned by others. The franchise to own and operate these facilities is the domain of the common carrier.

  - Facilities other than voice telephone circuits are almost nonexistent today, and, while improving, will be very limited for the foreseeable future.

  - Users planning to implement such facilities on their own face tremendous obstacles.

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- On the other hand, intrabuilding networks are contained entirely on the users' premises, and users can implement anything they can afford. There is a growing number of alternatives available.

- Until recently, the local telephone company has been used exclusively to provide the inside wiring for telephone and low-speed data terminal connections within a building. They have used special wiring supplied by computer manufacturers to interconnect high-speed data equipment such as cluster controllers and batch terminals.

- The requirements for local networks fall into five categories of applications, by equipment class:

  - Voice telephones.

  - Low-speed data terminals.

  - High-speed or clustered data terminals.

  - Electronic mail systems.

  - Special laboratory or factory data systems.

C. INTERCOMPANY COMMUNICATIONS

- The majority of the communications between a large company and its customers or suppliers utilize voice telephone or mail techniques. Intercompany message communications applications are generally handled on the Telex/TWX network.

  - While some of these applications consist of orders and transaction inquiries between companies, the majority of domestic applications

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center around communications between manufacturers and their transportation suppliers, particularly railroads or public warehouses.

- A high percentage of intercompany message applications are in the international trade area.

- In the area of intercompany data communications, there are two distinct levels of data communications system implementation.

    - One of these is in the nature of limited experiments of interconnecting the data processing systems of manufacturers and their customers or suppliers. There are a number of such cases between very large companies, e.g., within the food and automobile industries.

    - Most companies have a limited set of computer interconnections with their suppliers or customers. The major limitation appears to be a matter of compatibility.

- A more common intercompany data communications implementation is terminal-based services between a company and its network of dealers or distributors.

    - Primary examples are the networks established by automobile and heavy equipment manufacturers to communicate with their franchised dealers. These communications are often characterized by information services to these dealers beyond the simple transmission of transactions. Such additional services include, for example, inventory control systems, financial management tools, and customer service analysis tools.

    - Examples in other industries include travel agency terminals connected to airline reservation and ticketing systems, correspondent bank terminals, and insurance agent terminals connected to the parent organization.

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- In many cases, the terminal at the dealer's location will soon be upgraded to a more powerful data processing system.

    - In the banking industry many of the correspondent banks are implementing small business computers of their own, reducing the processing and other communications between them and the Fortune 50 bank to which they are connected.

    - Similar trends are occurring in the automobile dealer and heavy equipment industries.

D.   NETWORK AND USER CONSIDERATIONS

- The driving force behind most network changes is the users' desire for control. Control includes network management, cost stability, maintenance control, user access control, etc.

    - As a result, the fastest selling products in the communications market now incorporate network control capabilities. These include call detail recording systems in voice networks and centralized network control systems in data networks.

- User control means something slightly different in each type of network.

    - In voice networks: traffic knowledge and control of service delivery.

    - In data networks: network reliability and control of service delivery.

    - In message networks: responsibility for the network.

    - In facsimile networks: responsibility for the devices in the network.

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- In electronic mail systems: responsibility for the system design.

- About 90% of the large companies (Fortune 500/50) have on-line, interactive data communications networks. The remainder have RJE (remote job entry) or some other form of batch data communications network.

  - The networks are able to interface not only with multiple systems (sets of applications) but also with a wider range of devices that were previously incompatible because of speed, code, traffic pattern, etc.

- Of those firms which have two or more data networks, most have both batch and interactive networks.

- New networks or network expansions planned by large companies can be classified into two types:

  - Data processing center networks.

  - Host-independent data communications networks, usually using packet-switching technology.

- Most of the major companies also have message communications systems, often including a freestanding message switcher. In some cases these systems are quite large (often several hundreds of terminals).

  - These message networks are, however, in the process of migrating to other means, particularly into integrated data networks.

- The primary long-term applications that can be expected to remain in message systems are those with interfaces with external domestic and international companies.

- Growth in the facsimile segment will occur with the installation of the higher speed (two-minute and one-minute) devices.

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- A small number of companies have implemented electronic mail systems. In these cases, the user group is typically a specific department such as sales or engineering.

- Companies that have implemented an electronic mail system are generally either:

    - Companies with a vested interest in electronic mail, such as computer companies or office product manufacturers.

    - Companies with extensive and distributed technical groups.

- Electronic mail is definitely being studied by many companies as part of an office automation task force.

E. AUTOMATION IN THE HOME

- It will be easier to produce and deliver information processing equipment into the home and into small enterprises than it will be to utilize its communications applications.

    - Although software is available, training in the use of the equipment and software is limited.

    - Interconnection to business establishments is extremely limited.

    - Communications and access during prime business hours is limited and costly.

- Some of the applications related to communications for the home and small enterprises are:

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- Information and data base delivery.

- Small business/household computations.

- Appliance control by the resident of the home.

- Remote power company control of appliances.

- Fire/theft alarm control.

- Medical monitoring.

- Education.

- Entertainment, including games and, possibly, gambling.

F.   OFFICE OF THE FUTURE

- The office of the future market can be divided into three segments, according to size and type of user.

- The first segment contains large national and multinational companies within the Fortune 500 group. The top 50 will be the leading edge in the move towards the office of the future.

    - These companies will have highly sophisticated computer installations. Many will include intelligent communications networks with a combination of public, private, and specialized common carrier facilities.

    - These corporations will move quickly to decentralize their communications networks to allow some form of public intelligent network such as Tymnet, Telenet, or the SBS system.

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- The largest companies will elect to buy a private intelligent network for intracompany communications.

- Another approach will be to select a mainframe suppliers' network such as Digital's DECnet. Corporations in this segment have the technical expertise to undertake a conversion of this magnitude.

- There are several companies in the banking and insurance industries which have substantial network installations. Among these are: Bank of America, Citicorp, Continental Illinois National Bank & Trust Company, Bankers Trust Company, First Bank System, Inc., and Allstate Insurance Companies.

  - Government agencies, large university systems, and the next layer of Fortune 100 companies are candidates for early office of the future implementation.

  - The Fortune 500 will follow these leaders.

- A few leading-edge office automation manufacturers have been developing plans, installing pilot projects, or gradually implementing integrated corporate information networks for electronic business communications. These efforts are most often research and test projects for a commercial product offering. Among the companies are: IBM, Xerox, Sperry Univac, Honeywell, and 3M.

  - Large computer or telecommunications equipment manufacturers will be among the first companies to implement intelligent information networks.

- No vendor can supply all of the equipment and services required to implement these large, complex systems. Users will have to deal with several vendors, but they will select those who are accustomed to furnishing large installations.

  - IBM and similar large mainframe manufacturers will be primary suppliers.

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- AT&T will continue to dominate the telecommunications portion.

- Satellite Business Systems (SBS) and a few other well-financed organizations will contend for a portion.

- Suppliers of smaller systems will be able to obtain a share of the market by furnishing branch systems to interconnect to the main trunk.

● The second market segment is composed of medium- to large-size corporations.

- With the exception of word processors and computerized PBX, these companies will initially favor public intelligent networks for most automated office functions.

- Mainframe and minicomputer vendors, as well as remote computing and public intelligent network services, are likely suppliers to this market.

● Small- to medium-size companies form the third market segment. Most of these companies are local or regional. Many have a single office. Only a few have 20 or more locations. Other characteristics of this segment are:

- Single or limited number of products.

- Relatively small number of customers.

● Many of the organizations in this segment are new to automated office functions. In terms of numbers, they are the largest potential market. Many of them are turning to automation as a means of staying competitive.

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- There are numerous vendors who can satisfy the automation needs of the third market segment. Often, an integrated data and word processing system will meet the requirements of a company with a single location. However, the inclusion of communications capabilities to allow for future expansion is desirable.

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IV COMMUNICATIONS TRENDS AND DEVELOPMENTS

IV COMMUNICATIONS TRENDS AND DEVELOPMENTS

- One of the driving forces leading users of data communication networks to consider new solutions and methods of approaching their communications requirements is technology.

- Much of the technology applicable to data communication networks is derived from developments originated for the much larger voice communication marketplace. This is particularly true of the transmission elements.

A. TRENDS IN VOICE NETWORKS

- There are six basic network elements from which the voice network market-place is developed. These are shown in Exhibit IV-I.

1. LONG-DISTANCE TRANSMISSION

- Long-distance transmission represents the largest single identifiable cost in a voice network; usually representing 25% to 35% of the overall cost.

- While there are a number of technologies affecting long-distance transmission, such as satellite transmission and fiber optics, the change that is visible to users is pricing.

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EXHIBIT IV-1

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VOICE NETWORK ELEMENTS

NETWORK ELEMENTS	PRODUCT/SERVICE TRENDS	COMPETITIVE TRENDS	LONG-RANGE EXPECTATIONS
Long-Distance Transmission	Competitive Pricing	Large Competitors Only	Demand Level Pricing
Network Switching	Increased Network Control	Independents Gaining	Controlled Systems
Local Transmission	Solution Experiments	CATV? Rooftop Antennas? Radio?	Continuing Bottleneck
PBX	Increased Functional Capability	Independents Gaining	Services Distribution Point
Inside Wiring	New Technology	Deregulated	Battleground For Carriers/PBX/ Equipment Manufacturers
Telephone Instruments	New Technology	Supplied By PBX Vendor	Primary Employee Interface

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- Pricing in the communications industry, long a stable structure, is now becoming dynamic and competitive. Essentially what has happened is that where competition is present, prices have declined and where it is not, prices have increased.

- This does not necessarily mean that a "whatever the customer will bear" situation has developed, but rather that competition has been focused on the high-demand marketplaces such as transmission from New York to Chicago, and from New York to Washington D.C., etc.

- A new element of competition, the satellite carriers (primarily SBS), while originally focusing their marketing strategies towards data communications, have found the larger voice market more attractive. These new carriers, selling high bandwidth services, can also expect to see competitive products and pricing from AT&T.

  - The AT&T bulk service, TELPAK, was declared illegal and withdrawn in 1981. It is, however, unlikely that Bell will be without a bulk tariff for long. As soon as Bell has sufficient excess long-distance capacity, either through satellites or fiber optics, some form of bulk tariff is probable.

- In the long range, a continuation of the competitive pricing policies of the large companies can be expected. The end effect of this competition is that pricing will be oriented around the level of demand that can be sustained. Large users and large market areas will have relatively low-priced transmission capabilities available to them, whereas the smaller and more remote users will have to pay a higher price for transmission capabilities.

2. NETWORK SWITCHING

- Switching is essentially a tool whereby users can share the cost of transmission facilities that are only required for part of the time. It is in some areas of network switching that technology has made its greatest impact on communi-

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cations costs. Intelligent routing and operator/labor cost reduction have been the primary examples of this impact.

- A key trend is the increased level of control which new switching technology has provided to the network operator. This increased control is available to both public network operators such as AT&T, as well as private network operators.

- Improved network control manifests itself in forms such as the availability of detailed traffic data for later analysis and network optimization, the availability of transmission test routines, and of rerouting and network reconfiguration processes.

- The long-range expectations for network switching are that users will have a very tightly controlled network system in addition to some of the tests, analysis, and intelligent routine functions mentioned previously.

3. LOCAL TRANSMISSION

- Transmission facilities between users' premises and the nearest common carrier switching or long-distance transmission facility is the network element with the smallest set of available alternatives.

- Currently, better alternatives are not available or are not very promising. A number of organizations, recognizing the problem, are experimenting with solutions and may present practical solutions for the problem in the future.

- The most obvious source among alternatives are CATV providers. Yet these companies have, for the most part, avoided the extensive changes in their networks that would be required to serve a two-way communication requirement.

  - Most are only fulfilling the demand for entertainment.

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- One key exception is Manhattan Cable in New York City, which is installing capability and providing services for interconnection within the island of Manhattan.

- Another alternative, which has been used by a few companies, is digital microwave. It is a relatively expensive solution that can only be supported by high-volume, interbuilding requirements.

- Broadcast radio at microwave frequencies is another possible alternative. The Multipoint Data Service, now primarily a one-way service, is being examined by the FCC.

- As yet, there is no clear solution to this problem. Local transmission is expected to be a continuing bottleneck through 1990.

4. PBX

- The PBX (or PABX) is the on-site switching system which interconnects users within the premises and also connects them to the long-distance transmission facility. It is the PBX element of the communications marketplace that first gave extensive competition to common carriers.

- More recently, technology has allowed PBX products to develop an increased level of functional capability. PBXs are now largely sold on these features.

- In the future, a PBX will become a point from which a variety of services are distributed. In addition to simply being a control point for voice communications services, the PBX will provide the distribution and control, and possibly even the data base management function, of other services such as message, electronic mail, and low-speed data transmission.

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5. INSIDE WIRING

- The connection between the PBX and a telephone instrument is a "pair of copper wires." Until the onset of competition from independent PBX suppliers all of this inside wiring was, and most of it still is, provided by a common carrier.

- Inside wiring is an area receiving significant attention. Developing technology will stress wide band inside wiring for data applications. However, the voice network represents the high-volume application which can support an extensive installation cost. New technology, most of which centers around the use of shared, wide band transmission lines, has recently addressed some major questions about its application for voice services.

- The ownership and type of inside wiring is likely to be a battleground among common carriers, PBX manufacturers, and manufacturers of other equipment which require the use of inside wiring. Even now battles are taking place in the FCC and in the industry standards committees.

6. TELEPHONE INSTRUMENTS

- The basic telephone instrument, which remained unchanged for nearly a hundred years (except for the plastic cover and the touch-tone pad), is only now being impacted by new, solid-state technology in terms of cost reduction, new user enhancement features, and new system interfaces.

  - Cost reduction comes about by the conversion of electrical and electromechanical components into solid state chips. For example, the hybrid coil, a transformer-like device which converts the four-wire telephone operation into a two-wire operation for use on two-wire local loops, has been reduced to a chip and will be introduced into telephone sets in the near future.

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- New user features include small displays which can identify callers, schedule call reminders, etc. They also include single-function buttons rather than the control for the instrument through procedures such as switch hook flashing or special touch-tone code sequences.

- System features include digital encoding (codel) of voice signals for delayed transmission, and the encoding of special instructions such as conference calling or speed calling.

● Rather than voice communication functions being replaced by keyboard communications, technology is likely to establish voice communications in general, and the telephone instrument in particular, as the primary information tool for most employees in large organizations. The telephone instrument is likely to become the most powerful human interface providing additional functions over and above basic voice communications.

B. VOICE NETWORK ALTERNATIVES

● Until recently, voice communications have been primarily the domain of the telephone companies. New regulatory policies at the federal level have brought numerous new competitors into this field. They, in turn, are bringing new technology to bear on voice applications at a rate faster than Bell has introduced since its inception.

I. VOICE DIGITIZING

● Digitized voice transmission circuits, with over 100 million miles installed, represent a relatively small fraction of the approximately two billion miles of voice circuits implemented within the Bell system.

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- Digital carrier addresses a very specific and relatively narrow requirement for medium-distance, high-volume trunks between Bell switching offices.

- Similarly, digital carrier is not used to any great extent in the local loop plant which connects subscribers to a Bell central offices.

- Applications of digitization are new products which specifically digitize single voice circuits for transmission over standard data transmission channels.

 - One example is the voice digitizer developed by Time and Space Processing and introduced by CODEX earlier this year. This unit uses linear predictive coding to convert standard voice into a 2,400 byte-per-second transmission path.

 - A pair of such units costs approximately $25,000 and is only applicable on long-distance circuits.

- However, this technology of digitizing voice at low data rates which can more economically be transmitted over the long-distance facilities is almost certain to receive much more attention in the near future. New vocoder techniques, which are relatively expensive today, will be able to perform voice digitizing at the 2,400 bit-per-second level, and perhaps even lower, at prices which are likely to be comparable to the $3,000 price range now applicable to voice grade modems.

 - New voice coding and synthesis techniques, aided in large part by the technology of the "talking games" marketplace (such as Texas Instrument's "Speak And Spell"), are likely to be the guiding forces in bringing this technology to the communications field.

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2. VOICE MULTIPLEXING

- On overseas voice circuits, which currently cost in the range of $10,000 a month and up, techniques for gaining better utilization of groups of trunks have been applied for many decades. Specifically TASI (Time Assigned Speech Interpolation) has been used for many years by the Bell system. This technique, however, is only applicable to large groups of trunks.

- New implementations of this technique using more modern technology have been introduced recently by some vendors. Specifically, the COM-2 from Storage Technology Communications Corporation is applicable to trunk groups down to nine circuits. COM-2, like the Bell TASI, achieves trunk reductions on the order of a factor of two by taking advantage of the inherently half-duplex nature of voice telephone conversations.

- By 1985, users can expect to see combinations of intelligent multiplexing, voice digitizing, and TASI-type multiplexing available on a wide scale. One of the driving forces directing the development of this technology is the expectation of continuing large increases in Bell private-line rates.

3. VOICE STORE AND FORWARD

- At present, voice store and forward is in the experimental stage. These new applications will require extensive market development and user education to achieve any significant level of market penetration.

  - Experimental products from Electronic Communications Systems in Dallas are being tested by some major users. These users regard the product and its capabilities as too premature to draw significant conclusions; however, they do anticipate advantages in the implementation of electronic mail services through the use of these presumably more human-convenient voice entry and delivery techniques.

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- User acceptance of these rather expensive systems has been quite high.

- A California company, Televoice, Inc., is offering store and forward message services from its operations in Sunnyvale, CA.

- AT&T is experimenting with voice store and forward in a residential area of Philadelphia. The system, built around ESS technology with the addition of large bulk storage capability, has been delayed in its service introduction by the Pennsylvania Public Utility Commission.

    - The basis of the delay was a set of complaints from message service providers who regard voice storage service from Bell as an enhanced service in accordance with the terms of the Computer Inquiry II decision.

C. TRENDS IN DATA NETWORKS

- There are seven basic network elements which can be defined for data networks. These are shown in Exhibit IV-2. Most of these elements are analogous to the elements of the voice networks in Exhibit IV-1.

- While some companies are just reaching the point of implementing first-generation, on-line systems, other companies are implementing third-generation data networks, some of which are host-independent.

- This competition of concepts will probably extend for a number of years. Large mainframe companies, led by IBM, will expand the implementation of host-driven systems in the beginning of the decade; minicomputer companies will implement independent networks, and gain market position, later.

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EXHIBIT IV-2

DATA NETWORK ELEMENTS

NETWORK ELEMENT	PRODUCT/SERVICE TRENDS	COMPETITIVE TRENDS	LONG-RANGE EXPECTATIONS
Computer/ Front End	Host-Driven Versus Independent Networks	Concept Competition	Independent of Network
Long-Distance Transmission	Increasing Bandwidth	Large Competitors Only	Integrated with Voice
Data Switching	Network Control Systems	Minicomputers Gaining	Distributed Control
Local Transmission	Solution Experiments	CATV? Roof-Top Antennas? Radio?	Continuing Bottleneck
Modems	Performing Tests	Equipment Versus Systems	- Part of Control System - Digital Service Units
Inside Wiring	New Technology	Deregulated	Combined PBX/ Wideband
Terminals - Operator - Media - Transaction	- Simple, High-Growth - Intelligent - Multifunction	- Price Delivery - System Manufacturers - Industry Marketing	- New Technology - Local Processors - Multifunction

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1. LONG-DISTANCE TRANSMISSION

- The market for long-distance data transmission is almost identical to the voice transmission market except that there are more technical alternatives available in the data network market.

- Increasing bandwidth will become an important product capability, especially for high-volume network users.

2. DATA SWITCHING

- All of the sharing and cost-reducing elements of the network are included in this category.

    - Concentrators.

    - Multiplexors.

    - Message switchers.

    - Packet switchers, etc.

- This is where the actual control of the network is placed in the independent network concept.

- Minicomputer manufacturers and the other intelligent network hardware manufacturers will be competing for position and for market share against the mainframe manufacturers.

- Users' investment in installed terminals will be an increasingly significant factor in dictating network strategy.

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D.   DATA NETWORK ALTERNATIVES

I.   SNA (SYSTEMS NETWORK ARCHITECTURE)

- The development of data communication networks is, in a great many ways, tied to developments by IBM.

- The rationale for the development of SNA is that, prior to SNA, communication problems were being tackled on an ad hoc basis, resulting in:

  - About 200 different products relating to communications.

  - About 35 different teleprocessing access methods.

  - About 15 different data link controls.

- The initial introduction of SNA included the following specific products:

  - VTAM as the teleprocessing access method in the single-host CPU.

  - 370X communication processor to off-load line management details from the CPU.

  - NCP as the operating system for the 370X.

  - SDLC (Synchronous Data Link Control) as the link control discipline with a line of terminals and cluster controllers including the 3767, the 3770, and the 3600 Industry Terminals; later, the SDLC-compatible versions of the 3790 and 3270 families.

- As evidenced by Exhibit IV-3, the conversion rate of large users to SNA is clearly growing. The reasons for this acceptance include:

EXHIBIT IV-3

PENETRATION OF SNA AMONG

FORTUNE 500/50 COMPANIES WITH ONLY IBM HOSTS

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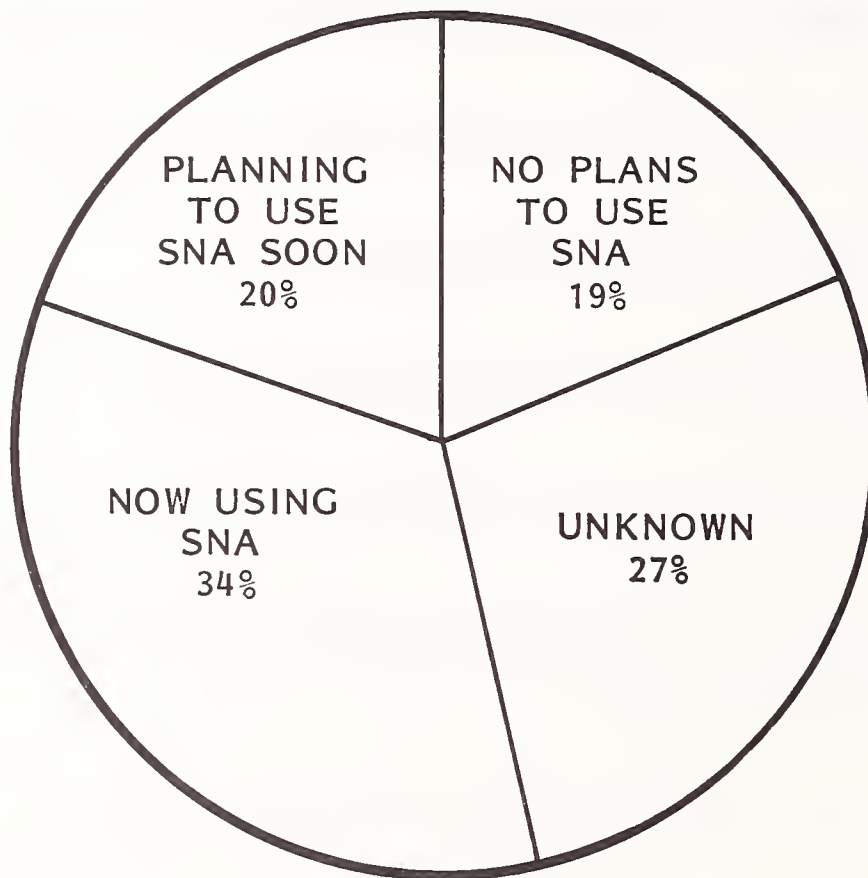
- The cost of the required extended amount of memory has come down dramatically since the initial introduction of SNA.

- IBM backed down from its initial inflexible position and now permits X.25 interfaces, ASCII Terminals (including IBM's own 3101), and the popular TCAM software within the SNA framework.

- More powerful features, including multisystem network facilities allowing the operation of multiple hosts, network management, and control capabilities (NCCF and NPDA), support multiple interhost links and alternate routing algorithms.

- IBM continues to exert pressure on users to move deeper into SNA by making more software products dependent on SNA and dropping support for previous non-SNA-compatible versions.

- Many more products are now supporting SNA, including 4300s and 8100s, allowing for an effective DDP network.

- In addition, new intelligent modems and a variety of competitively priced SNA-compatible terminals have been introduced providing IBM with a very complete product line of SNA-compatible hardware and software.

- A fundamental concept in SNA, and indeed in several other of the better-defined network architectures, especially the OSI Reference Model (OSI, Open System Interconnection), is one of separating the functions involved in communications between end users into several distinct layers and sublayers. The primary objectives of this separation are:

  - To make each layer self-contained so that changes to it will not require comparable changes in other layers.

  - To make the inner layers transparent to outer layers.

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- While many of the original criticisms of SNA have been answered by improvements made over the last five year, a number of criticisms remain. SNA is inherently a host-oriented architecture. Many of the protocol layers are implemented within the host access method. This includes presentation, transmission, and data flow control.

    - SNA is not particularly well-suited to the merging of data, voice, and other networks, especially when compared to the OSI architecture.

2. LOCAL DATA NETWORKS

- While many data terminals are distributed to locations remote from the host computer site, a large percentage of terminals remain in the same building. Many have been distributed around the building to various operating organizations so that access to the host computer can be accomplished conveniently.

- In addition to these data terminals, there is a growing array of other kinds of processing equipment located in functional departments which also needs occasional or frequent connection to the large mainframe.

    - These devices are usually minicomputers, but may also include other more specialized equipment such as laboratory instrumentation systems, process control systems, and energy and security management systems.

- The communications connection between these terminals and other information systems and the large mainframe center has had two alternatives in the past: the installed voice system (the PBX network) and separate dedicated wires installed specifically for that device.

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- Neither of these solutions is completely satisfactory. The dedicated line is a very expensive solution. The use of the PBX places not only speed and sometimes noise limitations on the terminal operation, but also adversely impacts the performance of the PBX system due to the long holding times that are often involved.

- A number of shared, wide-band circuit solutions have been developed over the last few years to address this problem. None of these has yet captured any significant fraction of the marketplace.

  - Most of the solutions share a coaxial cable or, in a few cases, propose the use of a fiber optic cable.

- Among the coaxial cable-based systems, the most experienced multiplex system is provided by AMDAX (previously called American Modem Company). This system, which is installed in a number of manufacturing plants, uses CATV components and places radio frequency modems at each of the drops.

  - One of the advantages of this kind of system is that the single coaxial cable can also carry other kinds of signals, such as video for security monitoring and voice, with the proper type of carrier equipment, on another TV channel.

- The other approach to the implementation of local data networks is time division or line switching. Again the line is usually a coaxial cable, but there are dozens of different approaches to the manner in which the cable is to be timeshared.

  - Most of the alternatives use some variant of packet-switching techniques.

- Ethernet is probably the best known system for local data networks. It is a concept basically developed at the Xerox research center.

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- Ethernet is a base band coaxial cable system operating at 10 megabits per second. Interfaces to this network must be designed to Ethernet specifications. Xerox has introduced two products which interface to the Ethernet system: the model 860 word processing system and, more recently, the model 5700 high-speed laser printer system.

- Intel is expected to produce chip sets, compatable to any manufacturer's hardware, which provide an interface to the Ethernet system. DEC is expected to produce high-level architecture products through which large data processing systems can be interfaced into the same Ethernet system.

3. AT&T DATAPHONE DIGITAL SERVICE (DDS)

- DDS (first announced in 1974) is the first major attempt since Datran to establish a national "all digital" communications network service. DDS currently services 61 major city calling areas in the United States.

    - AT&T has announced plans to expand the service to a total of 96 cities by the end of 1981.

    - In addition, the company is evaluating at least 12 other city calling areas for possible inclusion, and expects to apply for FCC approval.

    - In each city calling area, hub access is restricted to within a 50-mile radius. AT&T has stated that current technology is in place to extend this radius up to a minimum of 75 miles.

- Dataphone Digital Service is a 24-hour, seven-day-per-week service that is available on a full-period basis only. The service accomodates transmission speeds of 2,400, 4,800, 9,600, 56 Kbps and 1.544 Mbps in full-duplex mode.

- For long-distance, interstate routes, DDS competes with both the satellite carriers and the suppliers of private line services.

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- For digital data traffic, the service has the advantage of being an "all digital" network; no expense is thus incurred by users to convert signals from analog to digital or digital to analog formats.

4. RADIO AS A LOCAL TRANSMISSION FACILITY

- Both analog and digital microwave radio systems are available to users as an alternative to carrier offerings for short- and long-distance transmission of voice, data, or video traffic.

    - A major advantage of a privately owned, digital microwave system is the extremely high transmission speed at which it operates.

    - Another potential advantage is in the overall system's cost. However, the economic justification requires a large traffic volume.

- While analog microwave radio systems have the advantage of superior channel capacity for analog voice services, digital microwave systems are rapidly overtaking this more mature technology.

    - Digital microwave systems have several important advantages over analog counterparts, including lower overall systems cost (as noted above) and superior digital coding formats.

- It is important to note that an application for a construction permit must be obtained, and this requires a rather expensive "Non-Interference Analysis" to be conducted and submitted as a part to the application.

    - Estimates of the cost for the analysis vary widely in different geographic regions of the U.S. The more densely populated areas carry the burden of higher costs. It has not been unusual to hear of estimates as high as $75,000 to $100,000 for the analysis.

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- Despite seemingly high costs, digital microwave systems compare favorably with competitive technologies as shown in Exhibit IV-4; remembering, of course, that private and industrial usage of any microwave system is particularly appropriate for relatively short-distance communications applications.

5. SATELLITE COMMUNICATIONS

- Satellite communications are (by nature and by design) insensitive to distance for voice, data, and video traffic. These applications are generally considered economic by medium and heavy users at distances exceeding 500 miles.

    - When coupled with high-speed, private, microwave, ground-based systems, there is practically no area in the 48 contiguous United States that cannot be accessed.

    - For distances less than 500 miles, terrestrial microwave systems can prove to be more economical than satellites.

6. FIBER OPTIC CABLE SYSTEM

- The primary advantage of fiber optics is that fiber optic cables are able to carry a greater amount of traffic than other transmission media. The planned FT-3 system from the Bell system will use a number of 12-ribbon, 144-fiber cables enclosed in a one-half inch polyethylene and wire sheath, each capable of carrying an excess of 40,000 voice-grade channels.

- A second advantage of fiber optics is its future economies of scale in terms of both lower systems cost and the reduction in outside plant construction costs.

    - The capacity of the FT-3 system is such that direct replacement of coaxial cable within existing conduits allows for orders of magnitude expansion without need for additional construction expenditures.

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EXHIBIT IV-4

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COMPARATIVE PER CIRCUIT MILE COST
OF DATA NETWORK INSTALLATIONS

TRANSMISSION MEDIUM	COST (1978 Dollars)			
	1978	1979	1990	2000
Digital Microwave	$34.0	$27	$12	$ 8
Fiber-Optic Cable	34.4	21	10	7
Coaxial Cable (L-3)	38.0	35	29	27

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- The longest successfully installed non-carrier route is an intracampus system extending over a seven-mile link.

• In addition to voice and data trunking applications, the market for fiber optic communications is finding its way into applications for intrabuilding, computer-to-computer and computer-to-input/output devices cabling, as well as many other applications, including the provision of electromagnetically immune communications lines for monitoring high-voltage electric power stations and nearby nuclear power facilities.

7. FACSIMILE EQUIPMENT AND SERVICES

• A major obstacle to facsimile equipment usage has been the incompatibility of manufacturers' offerings both within product lines and with other manufacturers' equipment.

  - The development of technological standards for compatibility was completed by Study Group XIV of the CCITT (International Telegraph and Telephone Consultative Committee).

  - The adoption of the CCITT standards promises to lend significant market potential to an extremely diverse array of products.

• An alternative to establishing a private facsimile network is provided domestically by three companies:

  - ITT: FAX-PAK.

  - Graphnet: FAXGRAM.

  - Southern Pacific Communications: Speedfax.

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8.   SMALL BUSINESS AND CONSUMER COMMUNICATIONS

- Another mode of interorganizational communications likely to have very long-term significance in business communication applications is that of communications with the ultimate end user, the consumer.

    - One major example is audio response. Audio response capability is implemented in a number of banks; first for the use of tellers to inquire about customer accounts, and later expanded for use by customers for similar applications. This mode of communications can be expected to expand dramatically, not only in the banking industry, but also in a number of other consumer-related industries.

- More formalized direct exchanges between consumers and major companies can be anticipated in the form of interfaces with specialized terminals, particularly the various video-based terminals.

    - Experiments under way in a number of cities (specifically, Coral Gables, FL; Albany, NY; Columbus, OH; Washington, D.C.; Austin, TX; and probably a number of others in the near future) are exploring the use of television-based terminals to communicate a variety of both information services and transaction-handling capabilities between companies and consumers in their homes.

- The use of home computers to interface with companies' data systems is a long-term development.

    - One early example of this is an experiment announced by the United American Bank in Knoxville, TN, called "Express Information," which will allow home computers to communicate with the bank to pay bills, receive account information, and apply for loans.

- The impact of consumer-related applications is likely to be felt in the information services and communications marketplace shortly. It is certain to have a significant impact not only on communications networks but also on the education of end users in their relationship to information systems.

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V IMPACT ON INFORMATION SERVICES VENDORS

V   IMPACT ON INFORMATION SERVICES VENDORS

A.   OVERVIEW

- The circuit-switched public telephone network, along with private line services from AT&T, will continue to play a major role in data communications for a long time to come.   Nevertheless, there are situations where alternative offerings may be more cost effective.

    - Specialized offerings from AT&T (e.g., FX and CCSA).

    - Standard and specialized services from other common carriers (e.g., Western Union).

    - The current mix of voice and leased lines will continue through 1986. In a recent INPUT survey, the cost of data communications for large RCS firms averaged 9.1% of total revenues.

    - In another survey, AT&T charges ranged from 3% to 50% of the total network cost for larger RCS vendors.

- As the result of recent AT&T tariff changes:

    - Private wire costs are increasing substantially.

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- Heavy-use WATS line cost is increasing substantially.

- Low-use WATS cost will be level.

- Local business line access is increasing substantially.

• As a consequence, the costs for WATS-dependent services, such as certain cash management services, have risen substantially.

• Overall, the price increases has been passed on to customers in computer connect time.

• Practically all the RCS vendors now offer a nationwide (and sometimes, international) network of computing centers, interconnected by communications facilities (in some cases, advanced microwave and/or satellite links).

• This makes RCS vendors a viable alternative to the establishment of a private DDP network. In certain respects, RCSs can be regarded as natural competitors to the VANS (Value Added Network Services).

• Among the leading RCS firms with extensive networking capabilities are:

- Automatic Data Processing.

- Boeing Computer Services.

- CDC's Cybernet.

- Computer Sciences Corporation's Infonet.

- General Electric's GENET.

- National CSS.

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- Tymshare.

- United Information Systems.

• INPUT believes that the FCC order in the Second Computer Inquiry will encourage the extension of current offerings by processing services companies and hardware vendors, especially in the area of network management facilities. The fear of aggressive regulatory action has effectively been removed regardless of how long the FCC ruling is tied up in the courts.

• Communications carriers will also be inclined to pursue "enhanced services" which would have previously been categorized as computer services. For example, a value added network will be able to offer electronic mail and data base services through its on-site hardware and, will compete with current RCS offerings.

• While the FCC order has already been appealed and will probably spend years in the courts, it should have immediate benefits for users as all vendors attempt to provide more comprehensive services. The increased competition will result in lower and more competitive computer and communications services.

• The current mood in the FCC is towards deregulation, and the current federal administration will not reverse this trend.

  - The restriction of requiring a separate organizational entity for marketing "enhanced services" was removed from GTE. Since GTE has already acquired Telenet, its capabilities for expanding into the data base area are excellent.

  - Tymshare, which formed TYMNET as a VAN, is very interested in providing data base services using three data base systems: EXPRESS, FOCUS, and MAGNUM. With the FCC ruling, direct marketing of combined computer/communications services may begin.

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- Those computer services companies that have not spun off separate organizations for communications services will now feel free to provide network services without fear of regulation.

- During the last five years, applications utilizing networks have grown in number and usage on RCS.

  - Cash management systems, one of the fastest growing network applications, use the capabilities of ADP, GEISCO, NDC, IDC, and other RCS vendors.

  - Network applications in the distribution and manufacturing industries use the capabilities of Xerox, Tymshare, GEISCO, and other vendors.

    . These applications link different computers, terminals, communications lines, and methods to gather and aggregate data from plants, divisions, and offices of companies.

    . Many of these applications serve dispersed processing needs within one firm as well as communications between separate firms.

- Important trends in the information services industry in this period included:

  - Further development and use of DBMS.

  - The growth of proprietary data bases.

  - The increase in network applications.

  - The growth in revenue of software products.

  - Remote computing services will emphasize value added processing during the 1980s.

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- Network services will collect data which can be aggregated on the processing services.

- New proprietary data base services will add value.

- Value will also be added through fast-track development on remote processing.

- Data communications is a "world of change" at this moment.

    - Demand for national and international service is increasing.

    - Value added network services and RCS vendors are competing with different alternatives to serve local, national, and international needs.

        - Packet networks, dedicated lines, and mailgrams have been proposed as alternative delivery methods for financial reports.

    - Many large corporations are developing their own voice and data systems.

- Many companies may decide to utilize data communications capabilities of RCS vendors such as BCS, GEISCO, or Tymshare, or use carriers or value added services such as Telenet, Graphic Scanning, EMCA, etc. rather than expose themselves to the risks of changing technology.

- Larger RCS vendors should consider the addition of value added processing, developing (expanding) their own networks, and possibly becoming bulk or wholesale suppliers.

    - Large RCS vendors should also consider becoming value added network suppliers. In several cases they have already done so.

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- Although INPUT believes that large-scale systems will continue to be important, their growth will decline. The performance level associated with today's large-scale systems will be equaled by the medium-scale systems of the mid-1980s; these will serve the needs presently served by large-scale system reduced by the off-loading of applications to minicomputers and intelligent terminals as a result of distributed data processing.

    - As much as 40% of the commercial applications now performed by large-scale central computer facilities could be off-loaded to mini-computers and intelligent terminals.

    - Eighty percent or more of the commercial data base applications could be distributed by 1990. The key obstacle is the lack of appropriate software.

- Merging technological and market forces will result in explosive growth in the market for on-line data base systems in the late 1980s. Advanced technologies causing this to take place include:

    - Wideband information distribution channels, including satellites, fiber optics, and coaxial cable communications.

    - Imaging data entry systems, such as data scanners and video imaging.

    - Consumer terminals, including home TV/telephones costing less than $100.

    - Office automation systems, effectively integrating such functions as word processing, electronic mail, and filing.

    - Mass storage devices, including video disk, with an increase of three to four or more orders of magnitude storage capacity, at considerably less than current prices.

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- The net result will be a huge increase in information available through on-line data base services to both corporate users and consumers, replacing increasingly expensive labor- and resource-intensive printed publications.

- Cable television, a key to wideband data distribution to the consumer marketplace that is rapidly expanding in major cities, will offer on-line data base services to consumers and commercial establishments.

- The development of mini/microcomputer-controlled office automation (including word processing) systems increases both the availability of on-line terminals for accessing data bases and the ability to capture data base information as a by-product of normal daily business operations.

- INPUT's study, <u>Selling Personal Computers To Large Companies</u> defined personal computers as systems selling for under $15,000.

  - INPUT estimated that by the end of 1980 there were 85,000 systems installed in large companies, and forecasted growth to 600,000 systems by 1985.

- User companies are making network changes at a faster rate than ever before; the major ones are consolidating data and voice, consolidating the number of separate data networks, and extending data networks to more end users.

- Significant findings of a recent INPUT study were:

  - Fourteen percent of the study respondents had implemented or were in the process of implementing DDP systems.

  - Another 52% of the respondents had DDP under active consideration.

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- About one-third of all users interviewed had used outside consultants and professional services vendors in the design and/or implementation of their on-line systems. In general, acceptable systems were delivered.

- A number of services are being provided by information services vendors. These include:

  - Systems development.

  - Hardware and software problem diagnosis and maintenance.

  - Training in operations and programming.

  - Archiving and retrieval procedures.

  - Storage of backup files at vendor sites.

B.   OPPORTUNITIES

I.   MARKET OPPORTUNITIES

- Those companies with extensive dealer/distributor operations, such as auto-mobile manufacturers, airline companies or travel agents, insurance com-panies, etc., have a major requirement to communicate with dealers. In many cases the requirement is presently being met, at least partially. But in all cases, met or not, changes in relationships and in dealer-located equipment dictate a new type of network capability.

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- There are perhaps 1,000 dealer networks potentially possible within the Fortune 500/50 market, about 100 of which were identified in INPUT's study, <u>User Communications Networks and Needs</u>. Some of these are known to be $10 million/year networks.

- Many industry groups or trade associations (such as those in banking, airlines, railroads, retailers, etc.) are not only becoming involved in research and consulting services for their members but are also establishing communication networks to serve their industries. These groups potentially represent large new customers as well as focal points for developing an understanding of industry requirements.

  - About 50 different industry groups are capable of being the focal point of an industry communication network. ARINC, for example, is a $100+ million/year operation.

- Although an organized market for electronic mail does not yet exist in terms of defined customers, product patterns, or strategy, the fact that end users in large companies are establishing their own capabilities leads very clearly to the conclusion that there is a sizable market opportunity.

  - This opportunity might be addressed as either a service offering (Telemail, On-Tyme, Comet, etc.) or as a hardware or software product.

  - Initially, there are between five to fifty groups in each of the Fortune 500/50 companies that are electronic mail prospects. These include engineering teams, sales departments, legal departments, product development projects, market research projects, etc.

2. SYSTEM OPPORTUNITIES

- Few companies have implemented any kind of full-scale network management system, but most are heading in that direction.

INPUT

- In voice networks, a network management system would be a combination automated trunk monitoring system and traffic analyzer.

- In data networks, a network management system would be an automated network control system and a system performance analyzer.

- The ultimate market for network management systems among the Fortune 500/50 companies is about 2,000 systems at a cost of $1 million each.

- In most facsimile networks there is effectively no control at all. All of the functions to which data and voice network users have grown accustomed, such as automatic route selection, call queuing, message forwarding, unattended operation, and multidevice access compatibility, are missing from facsimile networks.

    - Furthermore, these networks exhibit rapid growth accompanied by a strong desire on the part of communications managers to establish control.

    - Network management systems for facsimile are a possible future step.

    - Facsimile control networks, either hardware- or service-based and either with or without transmission capabilities, represent a potential market of up to $200 million/year.

- As noted, the local transmission facility between the user's building and the nearest carrier office is an immense bottleneck to efficient network implementation.

3.   MARKETING ISSUES

- A very limited number of companies (less than 10% of the Fortune 500/50, and not necessarily the largest ones) have a solidly qualified communications

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organization capable of understanding its company's requirements, and, at the same time, have its management's confidence to act on these requirements.

- These few companies are generally known to the communications industry, both their peers and their suppliers, although not to information services companies.

- These leading-edge users are qualified both to recognize and to experiment with useful new products and to speak with authority about their results.

- With the "approval" of some of these leading-edge users, a new communication product or service can be successfully marketed in relatively short order.

- Without such "approval," market development will be difficult to impossible.

- Products addressing new application areas should be sold to functional groups. If the user organization is being asked to buy a product for an application area that is either new or unclear to the user, the functional group closest to understanding that application is a better choice to sell to than the communications staff.

- Products addressing defined user problems should be sold to the communications staff. New network products for voice or data are typically sold to a person who understands not only the requirements but also the advantages and disadvantages of alternative solutions.

- The influence of industry groups in the purchasing process is often substantial and must be recognized. This influence ranges from actually providing communications services (ARINC, railroads) to providing research and consulting guidance (retail, manufacturing). Whether users buy through these industry groups or simply follow their advice, they have significant influence, which is growing rapidly in the communications area.

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INPUT

- Particularly in the non-leading-edge companies, product features can be (and frequently are) very instrumental in the purchasing evaluation. New high-technology features, some of which may not even be effectively usable, have been used by vendors very successfully to sell products to this market.

- In-depth customer support must be provided. Bearing in mind that communication departments are generally understaffed, the introduction of new products and/or systems into a company will require much support. This support will include:

  - Consulting with the users' system staff on the proper use and installation of the product.

  - Training the users not only at the central site but at possible remote sites as well.

  - Possibly even operating the product or system on a turnkey basis.

- Vendors must protect their reputation carefully. The communication industry, particularly that segment made up of the major users and their suppliers, is a relatively small community in which a reputation, particularly for bad performance, can be established very quickly and disseminated even more quickly. Such was the case for specialized carriers' performance in remote areas. The reputation lost from these incidents, probably attributable to overextension of resources, will be difficult to regain and appears to have been avoidable.

- Expand telecommunications capability as a services offering.

  - Propose regional shared transaction networks to associations, common business groups, and corporations.

  - Develop and operate information switching systems to interface and integrate local/regional nets into national networks.

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- Utilize SBS and other wideband telecommunications networks to balance vendor computer center workloads for processing and for offering disaster recovery system services.

- Understand interactive cable technology evolving in consumer and business information marketplaces.

• Plan to use evolving video disk image storage and processing systems for use in consumer financial instrument truncation, storage, and processing applications.

• Develop and maintain mainline applications as national products with characteristics of:

- On-line interactive, transaction orientation.

- Central information file data base.

• Incorporate security sytems combining software and microprocessor control into network services offerings.

• RCS vendors should provide data communications and processing capabilities at the sites involved with their hardware services and use their networks to collect and disperse data. Data are consolidated on the RCS host or forwarded to customer centers.

- User site hardware services (USHS) permits development and testing of electronic mail, using the RCS vendor's networks and communications capabilities, without having to risk investment in hardware and communications services.

• Services offered to other information services firms will include the use of value added networks and licenses to use computers and software.

INPUT

- Both of these services are being sold to RCS firms today.

- The complexity of network services has increased sufficiently to make it too costly for small firms to develop a capability.

• Terminals, in their various manifestations, will provide numerous new opportunities to extend network services in RCS in the 1980s.

- Most vendors are not marketing terminals as OEMs.

- Many vendors are considering selling terminals because of their planned involvement in USHS or graphics.

• Vendors who have been selling terminals seem to have a number of advantages over those who do not:

- They benefit from their experience with field engineering support, logistics of delivery, maintaining inventory, negotiating contracts with manufacturers, and building profit margins.

- They are able to order proprietary features on their terminals that help to enhance or to lock in processing services.

- They are involved and play a major role in the strategic planning of terminal manufacturers.

• Two concurrent industry trends - distributed processing and office automation - are making communications requirements a paramount issue in all long-range planning involving data and/or word processing systems. Communications compatibility will become the crucial selection criterion as integration of such systems occurs, and services offerings which provide a total system combining hardware, software, and communications will become increasingly attractive.

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C.   RCS ACTION ITEMS

- RCS networks will, at a minimum, have to provide interfaces to packet networks, SDLC, and 3270 and other IBM terminals in order to obtain certain kinds of business. In some cases interfaces to a satellite ground station, Telex, TWX, ECOM, Mailgram, or a cable TV firm might be required.

  - RCS firms should offer flexibility in handling carriers, protocols, speeds, codes, terminals, and other equipment, etc.

  - RCS firms must develop these capabilities for themselves or have arrangements with vendors who do (e.g., Tymnet, Telenet, etc.).

- RCS networks will be a more valuable component of service since it will become more difficult to sell processing without value added services.

  - RCS vendors should spend more to develop network capabilities and upgrade them on a regular basis.

- During the next five years, RCS vendors who offer network services must develop strategies to counter increased competition from a number of sources including:

  - AT&T.

  - Western Union.

  - Companies with satellite capabilities.

  - Cable TV companies, networks run by hotels, travel agencies, railroads, real estate firms, and also industry networks.

- Competitive and service strategies should recognize:

INPUT

- Companies that have locked up contracts with satellites or who have satellites will capitalize on their cost and speed advantages.

- Real estate firms, hotels, travel agency chains, railroads, and other companies with a number of voice channels will take advantage of their investment and branch out into data communications (as Southern Pacific has done).

- Specialized networks designed for certain industries that may use unique codes and equipment. (Airlines and ARINC, insurance companies and ISOCOM).

- Western Union and then AT&T will begin to organize their marketing and product offerings in a more effective way to compete for business that could go to VANS or RCS firms.

- Communications competitors will offer proprietary data bases, processing, and other services that RCS vendors offer.

- Information services vendors should provide professional services for communications systems design since users will generally not have the flexibility to interface to the many communications services (over 25 carriers exist) or provide the variety of codes, formats, terminal interfaces, etc. that are required for networks.

  - Users can and will implement sophisticated networks, but many users will look to services firms with experience and flexibility for assistance.

  - The demand for data communications is increasing for both domestic and international services. Multinational firms have to collect and aggregate data. Distributors have to send out schedules for deliveries. RCS firms that supply network services will gain processing and other services as well as network business.

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INPUT

- RCS vendors should provide a "middle man" service that can interface to many or all carriers, protocols, speeds, modems, different terminals, and computers, including word processing systems. This service would aid private networks and other users to address the existing unorganized and fragmented situation.

- RCS vendors should by-pass AT&T costs and use satellites and cable TV or satellite reception tied into local PBX systems.

- RCS vendors should integrate new services in a network offering.

  - The integration of services for an industrial client could include a data base of parts from many vendors that would be provided to selected industries. Means of ordering and paying for the parts would be included.

  - Shopping at home on cable TV or phone and TV could be combined with payment services and entertainment.

  - The integration of services would require a breadth of datacom capabilities as well as processing and software development.

- Requirements for new data communication services should be investigated for network use such as:

  - Interfaces to satellite ground stations.

  - Interfaces to cable TV.

  - Use of SDLC and other new protocols, including Ethernet.

  - Hardware interfaces to PBX systems.

  - Interface to ECOM and the ability to package traffic in their requirements.

INPUT

- Interfaces to fiber optic systems which could have new protocols and equipment.

- Capabilities for handling standard or older communications offerings and terminals should be provided and offered with more flexibility than common carriers currently offer (e.g., use non standard addresses and message lengths).

INPUT

APPENDIX: GLOSSARY OF KEY COMMUNICATIONS TERMS

APPENDIX: GLOSSARY OF KEY COMMUNICATIONS TERMS

A. VOICE CONCEPTS

- CPBX (COMPUTERIZED BRANCH EXCHANGE) - A term generally used in the industry to describe a stored program, computer-driven PBX. It should be noted that the fact that a PBX is controlled by a computer does not necessarily mean that the switching is in fact performed by digital technology. In the Dimension PBX, for example, the switching is of amplitude modulated or analog pulses.

- DSI (DIGITAL SPEECH INTERPOLATION) - See TASI.

- FX (FOREIGN EXCHANGE) - A connection between a user location and a remote public telephone exchange whereby the user can send or receive calls as though he were a subscriber in that foreign exchange. The line between the foreign exchange and the user location is a private line.

- PBX (PRIVATE BRANCH EXCHANGE) - A private voice switching system serving an organizational entity and located at the customer's premises. On a PBX, calls can be made between stations at that site and to and from external networks such as the public telephone network or other company locations.

- T-CARRIER - A hierarchy of digital systems designed to carry speech and other signals in digital form, designated T1, T2, and T4. T1 carrier operates at

INPUT

1.544 megabits, T2 operates at 6.312 megabits, and T4 operates at 274 megabits. The Bell System is the primary user of T-Carrier systems and has about one hundred million voice circuit miles of these facilities in place. This represents approximately half a million T-Carrier circuits.

- TASI (TIME ASSIGNMENT SPEECH INTERPOLATION) - A process whereby multiple voice conversations can be transmitted over a reduced number of lines by making use of the gaps in typical voice conversations. Normally, only one speaker at a time is transmitting which, thereby, cuts the amount of traffic in half. In addition, most speakers have some fraction of time between words phrases. TASI and now, more efficiently, DSI take advantage of these gaps to place one voice conversation on about 45% of the otherwise required bandwidth.

- TELPAK - A bulk private wire service offered by the telephone companies. TELPAK C is a 60-voice channel group and TELPAK D is a 240-voice channel group. The continuing existence of TELPAK has been a subject of controversy for many years and was scheduled to be eliminated at the end of 1980.

B. DATA TRANSMISSION CONCEPTS

- CODEC (CODER-DECODER) - This is a device used to convert analog signals, such as voice, into digital form for transmission over a digital medium. This is the reverse process of a Modem which converts digital signals into analog form for transmission over an analog medium. At present, a Codec is a relatively expensive unit which is shared at a common carrier location or at a PBX. In the very near future, the Codec will be reduced in price to the point where it will likely be incorporated into every telephone hand set and the lines connecting a telephone to the nearest switching location will be operated digitally.

INPUT

- CONCENTRATION - With the advent of low-cost minicomputers, concentrators became popular, usually for large-scale networks (airline reservations systems, etc.). Concentrators, in the days of FDM and TDM, offered the ability to allow access input to exceed the throughput level of the backbone trunk because of their ability to buffer traffic briefly to smooth out utilization curves.

  - Concentrators typically perform control of the access network in terms of polling and selection of terminals, thereby reducing the central CPU loading and increasing trunk utilization by compressing concentrator/host dialogue to a batch-like format.

- DUV (DATA UNDER VOICE) - An arrangement for transmitting 1.544 megabyte per second datastreams in the bandwidth available underneath the portion of the microwave radio beam used for voice channels. DUV is the primary long-distance transmission facility used for Dataphone Digital Service (DDS).

- EIA INTERFACE - A set of standard signals and signal characteristics specified by the Electronic Industries Association. This terminology usually refers to the RS-232 C interface. The RS-232 C is being replaced on an interim basis by the RS-449 interface and ultimately by the X.21 interface.

- FDM (FREQUENCY DIVISION MULTIPLEXING) - Multiplexing, in general, subdivides the trunk circuit into fixed frequency banks. In both FDM and TDM, the amount of data or voice cannot exceed the total channel capacity of the trunk in either connections (voice) or throughput (data).

- FM (FREQUENCY MODULATION) - This technique, the same one used in FM broadcasting, is used extensively in voice communications to place multiple voice signals onto a transmission media such as a wire, radio channel, or microwave beam.

- ITDM (INTELLIGENT TIME DIVISION MULTIPLEXING) - These systems exploit microprocessor intelligence to exercise control of access terminals

INPUT

providing scheduling and prioritization to eliminate the above mentioned problem with batch streams and to increase overall trunk throughput.

- MODEM OR DATASET - A contraction of the words modulator and demodulator signifying an equipment unit that performs both of these functions. In addition to the modulation and demodulation function, a modem also performs other line interfacing functions. Hence, dataset is in fact a more appropriate term.

- MODULATION - A process of converting signals into frequencies so they can be transmitted more efficiently over analog transmission circuits. It often is related to the conversion of digital data pulses to transmission frequencies.

- MUX (MULTIPLEXING) - This is a technique in which multiple channels of communication are combined in a way that they can be transmitted on a single physical channel.

- PACKET SWITCHING - Perhaps the most sophisticated network organization available under current technology is packet switched. This technology has been implemented exclusively for data communications networks.

  - Packet switching calls for the separation of bit streams into blocks, or packets, which contain data as well as addressing information. Packet switched networks were initially developed by the Department of Defense's Advanced Research Projects Administration (ARPA) and led to the implementation of the Arpanet in 1969. Packet switched systems, in addition to providing speed, code, and protocol conversion, were desirable for defense applications where survivability considerations dictated distributed architecture with adoptive routing mechanisms. These systems are ideal for interactive, low-volume applications from widely dispersed local access users but the overheads induced by packed headers and other routing information (similar to statistical time division multiplexing discussed below) can cause severe degradation for throughput sensitive batch applications. Packet

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switched networks are implemented in two basic routing approaches; datagram and virtual circuit.

- STDM (STATISTICAL TIME DIVISION MULTIPLEXING) - Statistical Time Division Multiplexors have become more popular over the last few years. These devices exploit the idle times inherent in interactive applications to allow the number of access devices to exceed the throughput of the trunk by a factor of three of four. By addressing each block with a control header, higher utilization is achieved by interleaving blocks for transmission which are reassembled by the destination STDM.

- TDM (TIME DIVISION MULTIPLEXING) - Time Division Multiplexing subdivides the backbone channel into fixed time slots. TDM has become popular for the short-haul transmission of voice traffic with the Bell developed "T" family of carriers. These systems provide advantages in maintainability and reliability since they are digital and because they are linked to improving price/performance relationships for LSI technologies.

- VALUE ADDED NETWORK - A value added network (VAN) typically uses common carrier network transmission facilities and augments these facilities with computerized switching. These networks have become associated with packet switching technology because the public VANs which have received the most attention (Telenet and TYMNET) employ packet switching techniques. However, other added data service features such as store and forward message switching, terminal interfacing, error detection and correction, and host computer interfacing are of equal importance.

INPUT

C. COMMUNICATION SYSTEM CONCEPTS

- ELECTRONIC MAIL SERVICES - Electronic Mail Services (EMS) means document and message transfer by electronic transmission over voice grade telephone circuits. There are four types of electronic mail systems available today:

    - Facsimile: a system for transmitting words and images.

    - Public or private teletypewriter networks: a terminal-to-terminal form of communication.

    - Communicating word processors: a basic word processor with added transmission capabilities.

    - Computer-based message systems: interactive message systems which are completely user-oriented.

- FAST CIRCUIT SWITCHING - A form of switching for interactive traffic in which a circuit is established not for the duration of a session but for a message during an interactive session. The technique is somewhat analogous to TASI as used for voice circuits.

- FIBER OPTICS - The fiber optic system being installed by Bell utilizes physically pure strands of glass onto which digital light signals are applied. Each strand carries 672 voice channels totaling 44 Mbps and are grouped into cables, which are similar in dimension to traditional high-capacity cables, each carrying 144 strands. A single cable would carry about 100,000 channels with a bandwidth of 6.4 Gbps.

- MESSAGE SWITCHING - A process of receiving a message, storing, and then retransmitting that message. This term is often used interchangeably with store and forward switching.

INPUT

- **MICROWAVE** - The sometimes difficult task of laying cable with right-of-way problems or hostile geography led to the implementation of microwave radio transmission as an alternative. Microwave radio provides a reliable communications media which supports either analog or digital transmission. Some difficulties can be encountered with microwave radio transmission, particularly in the higher frequency bands (11 GHz and 18 GHz). Price/performance of digital technology allows these difficulties to be overcome, as less expensive repeaters are available for installation, minimizing the atmospheric noise problems which are primarily attributable to precipitation.

- **SATELLITES** - Communication satellites were introduced in the early 1960s with the launching of Telstar. While satellite communications have been implemented on both an analog and digital basis, it is anticipated that the major technological breakthroughs will occur in the digital low-power transmission environment.

    - Satellite transmission has suffered from inherent problems, particularly due to the costs of earth stations, but more significantly to the propagation delay induced by beaming a signal some 23,000 miles into space.

    - In voice communications, human dialogue can be severely disrupted by an overall 600-millisecond delay. Bell utilizes satellite transmission for only 2% of the connections established on the long-distance network. These connections are half hop, utilizing a satellite in one direction and terrestrial facilities in the other. This lack of utilization and single hop reflect concerns for the quality of voice transmission by a satellite.

    - Satellite transmission of data communications suffers even more. Propagation problems would add approximately 0.6 seconds to any interactive application and would severely impact the response time and throughput of batch systems if forward error correction techniques are not employed.

INPUT

- A number of experts feel that satellite transmission is a transitional technology for business communications which will be justified for the wide deployment of video transmission for teleconferencing applications. Once a video transmission is established to a location, low quality voice and limited batch transmission could be integrated for economies of scale.

D. PROCESSING

- The improving price/performance capabilities of mainframes, minicomputers, and particularly LSI-based microprocessors provide the greatest impetus to the digital revolution. The cost of microprocessors is dropping at a rate of 25% annually. While current microprocessor technology incorporates processors with 40 to 50 thousand circuit elements, it is anticipated that the number of elements will increase by a factor of 2.0 to 2.5 the next 18 months providing further opportunities to exploit computer-based processing power within the telecommunications environment.

- Typically the greatest advantage of digital processors for telecommunications is their ability to control, in real time, communications streams and provide greater utilization through a variety of compression techniques. With the advent of low-cost digital processing, time division multiplexing in its various forms becomes more cost effective. Most of today's sophisticated telecommunications system implementations rely, to a large degree, on time division multiplexing, which should not be restricted to its narrowest implementations of traditional time division or statistical time division multiplexors.

INPUT